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(54) COPPER ALLOY FOR ELCTRICALLY CONDUCTIVE SPRING AND ITS PRODUCTION

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a copper alloy combining excellent mechanical properties, conductivity, stress relaxation characteristics and bending workability.
SOLUTION: This copper alloy is the one having a compsn. contg., as essential components, by weight, 1.0 to 3.5% Ni, 0.2 to 0.9% Si, 0.01 to 0.20% Mg and 0.05 to 1.5% Sn, in which each content of S and O is limited to <0.005%, and the balance Cu with inevitable impurities, and the grain size thereof is regulated to >1 to 25 μm. Thus, this is suitable for terminals, connector materials and switch materials. Furthermore, as for the method for producing it, after cold working, recrystallization treatment is executed at 700 to 920° C.

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CLAIMS

[Claim(s)]
[Claim 1] The copper alloy for conductive springs which Mg is restricted 0.01 - 0.20wt% 0.2 - 0.9wt%, a 0.05-1.5wt% implication, S, and O content are restricted for Sn to less than [0.005wt%], respectively, nickel is consisted of the remainder Cu and an unescapable impurity in 1.0 - 3.5wt% and Si, and the grain size number exceeds 1 micrometer, and is characterized by being 25 micrometers or less as a principal component.
[Claim 2] The copper alloy for conductive springs which Sn is restricted 0.05 - 1.5wt% 0.01 - 0.20wt%, a 0.2-1.5wt% implication, S, and O content are restricted for Zn to less than [0.005wt%], respectively, 1.0 - 3.5wt% and Si are consisted of the remainder Cu and an unescapable impurity in 0.2 - 0.9wt% and Mg, and the grain size number exceeds 1 micrometer, and is characterized for nickel by being 25 micrometers or less as a principal component.
[Claim 3] a copper alloy according to claim 1 or 2 -- further -- 0.005-0.3wt%Ag and 0.01-0.5wt%Mn -- it chooses from 0.005 - 0.2wt% Fe, Cr, 0.05-2.0wt%Co, and 0.005-0.1wt%P, respectively -- having -- one sort or two sorts or more -- a total amount -- 0.005wt(s)% - 2.0wt% -- the copper alloy for conductive springs characterized by containing
[Claim 4] a copper alloy according to claim 1 or 2 -- further -- one sort of 0.005-0.1wt%Pb and 0.005 - 0.03wtBi, or two sorts -- a total amount -- 0.005 - 0.13wt% -- the copper alloy for conductive springs characterized by containing
[Claim 5] To a pan at a copper alloy according to claim 1 or 2 0.005-0.3wt%Ag, It Fe(s). 0.01-0.5wt%Mn -- respectively -- 0.005 - 0.2wt% -- It is chosen from Cr, 0.05-2.0wt%Co, and 0.005-0.1wt%P. One sort or two sorts or more, and one sort of 0.005-0.1wt%Pb and 0.005 - 0.03wtBi, or two sorts -- a total amount -- 0.005wt(s)% - 2.0wt% -- the copper alloy for conductive springs characterized by containing
[Claim 6] The copper alloy for conductive springs according to claim 1 to 5 characterized by being what used for a terminal, connector material, or switch material.
[Claim 7] The manufacture method of the copper alloy for conductive springs according to claim 1 to 6 characterized by performing recrystallization processing at 700-920 degrees C after cold working.
[Claim 8] The manufacture method of the copper alloy for conductive springs according to claim 1 to 6 characterized by performing an aging treatment at 420-550 degrees C after performing recrystallization processing at 700-920 degrees C after cold working.
[Claim 9] The manufacture method of the copper alloy for conductive springs according to claim 1 to 6 characterized by performing an aging treatment at 420-550 degrees C after performing recrystallization processing at 700-920 degrees C after cold working and performing 25 more% or less of cold working.
[Claim 10] The manufacture method of the copper alloy for conductive springs according to claim 1 to 6 characterized by performing 25 more% or less of cold working, and low temperature annealing after performing recrystallization processing at 700-920 degrees C after cold working and performing 25% or less of cold working, and a 420-550-degree C aging treatment next.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention relates to the copper alloy for conductive springs suitable for a terminal and connector material, switch material, etc., and its manufacture method about the copper alloy for conductive springs, and its manufacture method.
[0002]
[Description of the Prior Art] A copper alloy is conventionally used as a terminal and a charge of connector material, and many Cu-Zn system alloys, Cu-Fe system alloys excellent in thermal resistance, and Cu-Sn system alloys are used. Although many cheap Cu-Zn system alloys are especially used for the use of an automobile etc., it is the present condition that it is becoming impossible, as for the terminal for automobiles in recent years and a connector, for a Cu-Fe system alloy and an Cu-Sn system alloy to also correspond of course with a Cu-Zn system alloy since a miniaturization inclination is remarkable and it is exposed to the harsh environments in an engine room etc. in many cases.
[0003] Thus, the property for which a terminal and the charge of connector material are asked is also becoming severer with change of the environment currently used. Although a stress relaxation characteristic, a mechanical strength, thermal conductivity, bending nature, thermal resistance, the connection reliability of Sn plating, the migration property, etc. are variably crossed to the copper alloy used for such a use, it is a property with especially important a mechanical strength, a stress relaxation characteristic, the conductivity of heat and the electrical and electric equipment, and bending nature.
[0004] As a copper system material which fills such severe demand characteristics, the Cu-nickel-Si system alloy attracts attention, for example, JP,61-127842,A is known. However, it has lapsed into the state where such an Cu-nickel-Si system alloy cannot bear use, either. Specifically, when the tab width of face of the male terminal inserted in the miniaturization of parts, for example, a common core-box terminal, is miniaturized from 090 terminals which are about 2mm to 040 terminals which are about 1mm, the width of face of the spring section is about 1mm, and if parts are miniaturized in this way, it is difficult to obtain sufficient connection resilience. Moreover, although many devices are made by the structure of a terminal in order to secure the connection resilience in the spring section in relation to a miniaturization consequently, it is severer, and in conventional Cu-nickel-Si, the bending nature required of material is also bent and a crack produces it in many cases in the section. The same is said of a stress relaxation characteristic, and prolonged use is an impossible situation with the conventional Cu-nickel-Si system alloy by the increase of stress by which a load is carried out to material, and elevated-temperature-ization of an operating environment.
[0005] In order to improve a stress relaxation characteristic under such a situation, addition of Mg is effective, for example, the effectiveness of Mg is shown in JP,61-250134,A, JP,5-59468,A, etc. However, although a stress relaxation characteristic improves by Mg addition, the improvement of bending nature is indispensable for bending nature to deteriorate, to be unable to bear 180-degree adhesion bending, and to use it for an automobile connector etc. Moreover, although examination for improving bending nature was also carried out, since this was a strong low material, it was that from which a desired property is not acquired. Furthermore, if the conductivity of heat and the electrical and electric equipment is bad, in order that a stress relaxation characteristic may promote stress relaxation by self generation of heat as it is good, the balance of conductivity and a stress relaxation characteristic is important.
[0006]
[Problem(s) to be Solved by the Invention] Although the copper system material which examines bending nature, a stress relaxation characteristic, etc. and fills severe demand characteristics is proposed as mentioned above, this invention is a copper alloy which combines the outstanding mechanical property, conductivity, a stress relaxation characteristic, and bending nature, and offers the suitable copper alloy for a terminal and a connector.
[0007]
[Means for Solving the Problem] It is the copper alloy for conductive springs which this invention solves the above-mentioned technical problem, and Mg is restricted 0.01 - 0.20wt% 0.2 - 0.9wt%, a 0.05-1.5wt% implication, S, and O content are restricted for Sn to less than [0.005wt%], respectively, nickel is consisted of the remainder Cu and an unescapable impurity in 1.0 - 3.5wt% and Si, and the grain size number exceeds 1 micrometer, and is characterized by being 25 micrometers or less as a principal component. Moreover, in the above-mentioned composition, it is the range which does not have a bad influence on the property of this invention, and even if it adds other alloying elements, for example, less than 0.2% of Zn, it does not interfere. Moreover, this invention is a copper alloy for conductive springs which Sn is restricted 0.05 - 1.5wt% 0.01 - 0.20wt%, a 0.2-1.5wt% implication, S, and O content are restricted for Zn to less than [0.005wt%], respectively, 1.0 - 3.5wt% and Si are consisted of the remainder Cu and an unescapable impurity in 0.2 - 0.9wt% and Mg, and the grain size number exceeds 1 micrometer, and is characterized for nickel by being 25 micrometers or less as a principal component.
[0008] moreover, this invention is further chosen as the above-mentioned copper alloy from Ag, Mn, Fe, Cr, Co, and P -- having -- one sort or two sorts or more -- a total amount -- 0.005wt(s)% - 2.0wt% -- it is the copper alloy characterized by containing For nickel Si 1.0 - 3.5wt% as a principal component specifically 0.2 - 0.9wt%, For Mg Sn 0.01 - 0.20wt% A 0.05-1.5wt% implication, Further 0.005-0.3wt%Ag, 0.01-0.5wt%Mn, Respectively 0.005 - 0.2wt% Fe, Cr, 0.05-2.0wt%Co, It is chosen from 0.005-0.1wt%P. one sort or two sorts or more in a total amount A 0.005wt%-2.0wt% implication, It is the copper alloy for conductive springs which S and O content are restricted to less than [0.005wt%], respectively, it consists of the remainder Cu

and an unescapable impurity, and the grain size number exceeds 1 micrometer, and is characterized by being 25 micrometers or less. For nickel Si 1.0 - 3.5wt% as a principal component Moreover, 0.2 - 0.9wt%, For Mg Sn 0.01 - 0.20wt% 0.05 - 1.5wt%, Zn to a 0.2-1.5wt% implication and a pan 0.005-0.3wt%Ag, It Fe(s). 0.01-0.5wt%Mn -- respectively -- 0.005 - 0.2wt% -- It is chosen from Cr, 0.05-2.0wt%Co, and 0.005-0.1wt%P. one sort or two sorts or more in a total amount A 0.005wt%-2.0wt% implication, It is the copper alloy for conductive springs which S and O content are restricted to less than [0.005wt%], respectively, it consists of the remainder Cu and an unescapable impurity, and the grain size number exceeds 1 micrometer, and is characterized by being 25 micrometers or less.

[0009] moreover, the copper alloy of the above [this invention] -- further -- one sort of Pb and Bi, or two sorts -- a total amount -- 0.005 - 0.13wt% -- it is the copper alloy characterized by containing For nickel Si 1.0 - 3.5wt% as a principal component specifically 0.2 - 0.9wt%, For Mg Sn 0.01 - 0.20wt% A 0.05-1.5wt% implication, One sort of further 0.005-0.1wt%Pb and 0.005 - 0.03wtBi, or two sorts in a total amount A 0.005-0.13wt% implication, It is the copper alloy for conductive springs which S and O content are restricted to less than [0.005wt%], respectively, it consists of the remainder Cu and an unescapable impurity, and the grain size number exceeds 1 micrometer, and is characterized by being 25 micrometers or less. For nickel Si 1.0 - 3.5wt% as a principal component Moreover, 0.2 - 0.9wt%, For Mg Sn 0.01 - 0.20wt% 0.05 - 1.5wt%, Zn to a 0.2-1.5wt% implication and a pan 0.005-0.1wt%Pb, One sort of 0.005 - 0.03wtBi, or two sorts in a total amount A 0.005-0.13wt% implication, It is the copper alloy for conductive springs which S and O content are restricted to less than [0.005wt%], respectively, it consists of the remainder Cu and an unescapable impurity, and the grain size number exceeds 1 micrometer, and is characterized by being 25 micrometers or less.

[0010] moreover, it is further chosen as the above-mentioned copper alloy from Ag, Mn, Fe, Cr, Co, and P -- having -- one sort or two sorts or more and one sort of Pb and Bi, or two sorts -- a total amount -- 0.005wt(s)% - 2.0wt% -- it is the copper alloy characterized by containing For nickel Si 1.0 - 3.5wt% as a principal component specifically 0.2 - 0.9wt%, For Mg Sn 0.01 - 0.20wt% A 0.05-1.5wt% implication, Further 0.005-0.3wt%Ag, 0.01-0.5wt%Mn, Respectively 0.005 - 0.2wt% Fe, Cr, 0.05-2.0wt%Co, It is chosen from 0.005-0.1wt%P. One sort or two sorts or more, and 0.005-0.1wt%Pb, One sort of 0.005 - 0.03wtBi, or two sorts in a total amount A 0.005wt%-2.0wt% implication, It is the copper alloy for conductive springs which S and O content are restricted to less than [0.005wt%], respectively, it consists of the remainder Cu and an unescapable impurity, and the grain size number exceeds 1 micrometer, and is characterized by being 25 micrometers or less. For nickel Si 1.0 - 3.5wt% as a principal component Moreover, 0.2 - 0.9wt%, For Mg Sn 0.01 - 0.20wt% 0.05 - 1.5wt%, Zn to a 0.2-1.5wt% implication and a pan 0.005-0.3wt%Ag, It Fe(s). 0.01-0.5wt%Mn -- respectively -- 0.005 - 0.2wt% -- It is chosen from Cr, 0.05-2.0wt%Co, and 0.005-0.1wt%P. One sort or two sorts or more, One sort of 0.005-0.1wt%Pb and 0.005 - 0.03wtBi, or two sorts in a total amount And a 0.005wt%-2.0wt% implication, It is the copper alloy for conductive springs which S and O content are restricted to less than [0.005wt%], respectively, it consists of the remainder Cu and an unescapable impurity, and the grain size number exceeds 1 micrometer, and is characterized by being 25 micrometers or less.

[0011] Moreover, the above-mentioned copper alloy of this invention is characterized by being what is used for a terminal, connector material, or switch material. Moreover, this invention is the manufacture method of the copper alloy for conductive springs characterized by performing recrystallization processing at 700-920 degrees C after cold working. Moreover, after [which is the manufacture method of the copper alloy for conductive springs characterized by performing an aging treatment at 420-550 degrees C] performing recrystallization processing at 700-920 degrees C after cold working, performing recrystallization processing at 700-920 degrees C after cold working and performing 25 more% or less of cold working again, it is the manufacture method of the copper alloy for conductive springs characterized by performing an aging treatment at 420-550 degrees C. Furthermore, after performing recrystallization processing at 700-920 degrees C after cold working and performing 25% or less of cold working, and a 420-550-degree C aging treatment next, it is the manufacture method of 25 more% or less of cold working, and the copper alloy for conductive springs characterized by performing low temperature annealing.

[0012]

[Function] The copper alloy of this invention makes it the main point to carry out the amount addition of specification of Sn, Mg, and the Zn, and to restrict S and O content to the copper alloy which the compound of nickel and Si is deposited in Cu matrix, and has a suitable mechanical strength, and heat and electric conductivity, and to exceed 1 micrometer for a grain size number to it, and to improve a stress relaxation characteristic and bending nature as 25 micrometers or less. This invention persons find out that the material which has the property which was excellent as the copper alloy for conductive springs which has the property which was excellent in specifying the content of this copper alloy component in detail practical especially a terminal, and an object for connectors can be made to realize, and, as a result, get the copper alloy of this invention.

[0013] The reason for component limitation of the copper alloy of this invention is explained below. If Cu is made to contain nickel and Si, an nickel-Si compound will be made, this is deposited in Cu, and intensity and conductivity are raised. There are few amounts of deposits and target intensity [be / less than / 1.0wt% / the amount of nickel] is not obtained. Conversely, when the amount of nickel exceeds 3.5wt(s)%, it will have a bad influence also on about [that the intensity which casting and the deposit which does not contribute to an on-the-strength rise at the time of hot working arise and balances a content cannot be obtained], hot-working nature, and bending nature. Since the amount of Si is considered that the compound of nickel and Si which deposits is a nickel2Si phase, if the amount of nickel is determined, optimal Si content will be decided. Sufficient intensity cannot be obtained like the time with few amounts of nickel as the amount of Si is less than [0.2wt%]. Conversely, when Si content exceeds 0.9wt(s)%, the same problem as the case where there are many amounts of nickel arises. Preferably, it is desirable to adjust nickel and to adjust Si to 0.4 - 0.7wt% 1.7 - 2.8wt%.

[0014] Mg and Sn are important alloying elements which constitute the copper alloy of this invention. There are these elements with regards to mutual, and they have realized good property balance. Next, the reason for limitation of these elements is explained. Although Mg improves a stress relaxation characteristic sharply, it has a bad influence on bending nature. From a viewpoint of a stress relaxation characteristic, many contents are so good that there are at more than 0.01wt%. Conversely, if a content exceeds 0.20wt(s)% from a viewpoint of bending nature, it is difficult to obtain good bending nature. From such a viewpoint, the content range of Mg shows good balance in 0.01 - 0.20wt%. The more desirable content range of Mg is 0.01 - 0.1wt% from a viewpoint of bending nature.

[0015] Furthermore, it found out that a stress relaxation characteristic was more improvable, maintaining good bending nature by adding Sn. Although Sn has the improvement effect of a stress relaxation characteristic and the effect is not so large as Mg, it is with regards to Mg and mutual, and good property balance is shown. If Sn is contained exceeding 1.5wt(s)%, the conductivity of heat and the electrical and electric equipment will deteriorate, and a problem will be caused practically. Although Sn content

also has balance with the amount of Mg, 0.05 - 1.5wt% shows good property balance. Specifically, when Mg is 0.01 - 0.05wt%, 0.8 - 1.5wt% of Sn is desirable, and when the amount of Mg is 0.05 - 0.1wt%, 0.05 - 0.8wt% of Sn is desirable.

[0016] Bending nature is improvable although Zn does not contribute to a stress relaxation characteristic. Zn -- 0.2 - 1.5wt% -- desirable -- 0.3 - 1.0wt% -- by containing, even if it makes Mg contain to a maximum of 0.20 wt(s)%, it is satisfactory practically -- the bending nature of level can be attained moreover, the operation which Zn has the effect of improving the heat-resistant detachability of Sn plating or pewter plating, and a migration property, and improves punching processability -- having -- a practical viewpoint to Zn -- 0.2wt(s)% -- desirable -- more than 0.3wt% -- it is desirable to make it contain Although hot-working nature will be checked if Pb and Bi are added so much as an element which improves punching processability, although there are Pb and Bi, since Zn can improve punching processability, without having a bad influence on manufacturability, it is an effective alloying element. the upper limit -- the conductivity of heat and the electrical and electric equipment -- taking into consideration -- 1.5wt% -- it is 1.0wt(s)% preferably In addition, it is shown that it is in the better inclination at **** with Mg also from this example.

[0017] As mentioned above, although the reason which limited the addition range of Mg, Sn, and Zn was explained in full detail, it is limited within the limits of these elements, and considering as the maximum content, respectively is not desirable. The range of a content with the practically best balance is Zn:0.3 - 0.8wt% Sn:0.2 - 0.5wt% Mg:0.05 - 0.15wt%.

[0018] Next, the reason which limited the range of the content of Ag, Mn, Fe, Cr, Co, and P is explained. in that processability is improved, Ag, Mn, Fe, Cr, Co, and P have the analogous function, and choose it from Ag, Mn, Fe, Cr, Co, and P -- having -- one sort or two sorts or more -- 0.005wt(s)% - 2.0wt% -- it is made to contain

[0019] While Ag raises thermal resistance and raises intensity, it can prevent big and rough-ization of crystal grain, and can improve bending nature. Although adding the third various element was the place tried conventionally in order to raise the intensity of an Cu-nickel-Si system alloy, they were those in which conductivity is lowered sharply, or a bending moldability deteriorates, and the property which is not desirable as a use for electronic equipment appears. this invention finds out that Ag is effective, as a result of repeating examination of the element which improves intensity and does not have a bad influence on other properties. a content is less than [0.005wt%] -- the effect -- not appearing -- reverse -- 0.3wt(s)% -- since it exceeds, and no bad influence on a property will serve as cost quantity although there is if contained, the optimal content of Ag is 0.005 - 0.3wt%, and is 0.005 - 0.1wt% more preferably

[0020] Mn is effective in improving hot-working nature at the same time it raises intensity, and the effect corresponding to the content is not not only acquired, but [even if the effect is small in it being less than / 0.01wt% / and being contained exceeding 0.5wt%,] it degrades conductivity. Therefore, the optimal content range of Mn is 0.01 - 0.5wt%, and is 0.03 - 0.3wt% more preferably.

[0021] Fe and Cr combine with Si, form an Fe-Si compound and an Cr-Si compound, and raise intensity. Moreover, the trap of the Si which remains in a copper matrix, without forming a compound with nickel is carried out, and it is effective in improving conductivity. Since an Fe-Si compound and an Cr-Si compound have low precipitation-hardening ability, it is not a best policy to make many compounds generate. Moreover, if contained exceeding 0.2wt%, bending nature will deteriorate. The addition in the case of containing Fe and Cr from these viewpoints is 0.005 - 0.2wt%, and is 0.005 - 0.1wt% more preferably.

[0022] Co forms Si and a compound like nickel and raises a mechanical strength. Since it is expensive, although it compared Co with nickel, and it uses the Cu-nickel-Si system alloy in this invention, as long as it is allowed in cost, it may choose an Cu-Co-Si system and an Cu-nickel-Co-Si system. When an Cu-Co-Si system carries out an aging deposit, a mechanical strength and conductivity become good slightly from an Cu-nickel-Si system. Therefore, it is effective in the member ******(ed) in the conductivity of heat and the electrical and electric equipment. Moreover, since it is slightly high, as for an Co-Si compound, a stress relaxation characteristic also tends to be improved for precipitation-hardening ability a little. The optimal addition in the case of adding Co from these viewpoints is 0.05 - 2.0wt%.

[0023] P has the effect of improving conductivity at the same time it raises intensity. A lot of content promotes a grain-boundary deposit, and reduces bending nature. Therefore, the optimal content range in the case of adding P is 0.005 - 0.1wt%, and is 0.005 - 0.05wt% more preferably. Although what is necessary is just to have determined suitably according to the property searched for when two or more sorts of these were added simultaneously, it could be 0.005 - 2.0wt% in the total amount from viewpoints, such as thermal resistance, Sn plating, pewter plating heatproof detachability, and conductivity.

[0024] Next, the reason which limited the range of the content of Pb and Bi is explained. that to which Pb and Bi improve punching processability -- it is -- one sort of Pb and Bi, or two sorts -- 0.005 - 0.13wt% -- it contains Pb is an alloying element which improves punching processability. The charge of terminal material is asked for the more excellent processability with press improvement in the speed in recent years. It distributes in a copper matrix, and since Pb becomes the origin of destruction, it improves punching processability. When there is no property improvement effect that the amount of Pb(s) is less than [0.005wt%] and it adds exceeding 0.1wt%, in order to also degrade bending nature, 0.005 - 0.1wt% is the optimal and it not only reduces hot-working nature, but it is 0.005 - 0.05wt% more preferably. It is the alloying element which also pierces Bi and improves processability. 0. If the property improvement effect is small in it being less than [005wt%] and it adds exceeding 0.03wt%, the same property fall as Pb will be caused. Therefore, the optimal content range of Bi is 0.005 - 0.03wt%, and is 0.005 - 0.02wt% more preferably.

[0025] Although what is necessary is just to have determined suitably according to the property which is chosen from these [Ag, Mn, Fe, Cr, Co, and P], and is searched for one sort or two sorts or more and one sort of Pb and Bi, or when it contains two sorts simultaneously, it could be 0.005 - 2.0wt% in the total amount from viewpoints, such as thermal resistance, Sn plating, pewter plating heatproof detachability, and conductivity.

[0026] Next, the reason for having restricted S and O content to less than [0.005wt%] is explained. Usually, into a industrial copper material, S and O2 grade aims at realization of the property which was excellent in ****** rare ** conjointly with the convention of the grain size number to which this invention mentions these contents later with the alloy content mentioned above with restricting strictly. S is an element which worsens hot-working nature, is specifying the content as less than [0.005wt%], and raises hot-working nature. It is desirable to make especially S content into less than [0.002wt%]. Mg oxidizes that the content is more than 0.005wt%, and, as for O, bending nature deteriorates. It is desirable less than [0.005wt%] and to make O content into less than [0.002wt%] especially. Although contained in many cases in the usual copper system material at the minute amount, S and O which were explained above were important especially in the copper alloy of this invention, and the property excellent in specifying the content is acquired, and they found out realizing the suitable property for a terminal and the charge of connector material.

[0027] In the composition of the copper alloy of this invention mentioned above, in order to realize the property suitably, it is required for a grain size number to exceed 1 micrometer and to set to 25 micrometers or less. In a recrystallized structure, it is it easy to change with a mixed grain size that a grain size number is 1 micrometer or less, and a stress relaxation characteristic declines at the same time bending nature falls. Conversely, even if a grain size number grows exceeding 25 micrometers, it has a bad influence on bending nature. Therefore, a grain size number needs to exceed 1 micrometer and needs to adjust it to 25 micrometers or less.
[0028] Subsequently, the manufacturing method of the copper alloy of this invention is explained. Cold working, for example, after cold-rolling, the copper alloy of this invention heat-treats the making it solution-ize with recrystallization purpose, and quenches immediately. Moreover, an aging treatment is performed if needed. In order to exceed 1 micrometer and to adjust the grain size number in the copper alloy of this invention to the range of 25 micrometers or less, it is necessary to control the conditions of recrystallization processing in detail. Heat treatment at the temperature of less than 700 degrees C tends to serve as a mixed grain size, and in the temperature exceeding 920 degrees C, since crystal grain tends to grow big and rough, it performs recrystallization processing at 700-920 degrees C after cold working. Moreover, a cooling rate is quick as much as possible, and it is desirable to cool at 10 degrees C/s or more in speed.
[0029] Next, about the conditions of aging heat treatment, the amount of precipitation hardening is inadequate in aging temperature being less than 420 degrees C, and sufficient property cannot be pulled out. Conversely, if it processes at the temperature exceeding 550 degrees C, a deposit phase will grow big and rough and not only intensity falls, but it will reduce a stress relaxation characteristic. Therefore, aging-treatment temperature was made into 420-550 degrees C. Furthermore, it turns out that a stress relaxation characteristic receives influence in the state of a deposit phase greatly, and they are the best conditions near [where aging intensity shows a peak] the temperature. On the other hand, as for bending nature, it is desirable for aging intensity to heat-treat by the overaging side a little from the temperature which shows a peak. Processing at 460-530 degrees C is preferably the optimal from such a viewpoint.
[0030] Moreover, after performing recrystallization processing (solution-izing) at 700-920 degrees C after cold working and performing cold working (25% or less) further, an aging treatment is performed at 420-550 degrees C. Although the aging treatment was immediately performed after solution-izing in the example described later, it is also effective between solution-izing and aging to perform cold working. In this case, processing of 25% or less of reduction of area which does not degrade bending nature is desirable. Moreover, after performing recrystallization processing (solution-izing) at 700-920 degrees C after cold working and performing an aging treatment at cold working (25% or less) and 420-550 degrees C, 25 more% or less of cold working and low temperature annealing are performed. Thus, you may perform cold working after an aging treatment. In this case, in order not to degrade the bending nature which is the feature of this invention, processing of 25% or less of reduction of area is desirable. Furthermore, when performing cold working after the above-mentioned aging treatment, performing annealing at low temperature comparatively after that is recommended. In performing this annealing by batch-type annealing, when annealing between 0.5-5hr and ** performs at the temperature of 250-400 degrees C, it is desirable to carry out on conditions (5-60s) with the temperature of 600-800 degrees C. This annealing carries out the rearrangement of the transposition introduced by cold working, and has the operation which suppresses movement of transposition as a result. Therefore, when the above-mentioned cold working is performed, a stress relaxation characteristic can be improved by annealing. You may correct a tension leveler, roller BERA, etc. before the last heat treatment or to the back if needed.
[0031]
[Embodiments of the Invention] The copper alloy of this invention has the outstanding mechanical strength, bending nature, a stress relaxation characteristic, Sn plating detachability, punching nature, etc., is equipped with the property for which general electrical conducting materials, such as a terminal and connector material, switch material, and relay material, etc. are asked especially, and explains it in detail according to an example.
[0032]
[Example 1] The 1st example of this invention is shown in Tables 1-6, and it explains. Alloy composition of the example of this invention, Table 2, and Table 3 are alloy composition of the example of comparison, and the conventional example, and, in the property of the example alloy of this invention, Table 5, and Table 6, Table 4 shows [Table 1] the property of the alloy of the example of comparison, and the conventional example. In addition, the arrow of front Naka shows the same thing as the upper column, and the proof stress value of (*) is low, and since it caused plastic deformation in the sample set stage, it carries out a test stop.
[0033] First, with the RF fusion furnace, the alloy of the composition described in Table 1 - 3 was dissolved, and it cast with the cooling rate of 6 degrees C/s. The size of an ingot is 150mm in the thickness of 30mm, width of face of 100mm, and length. Next, since these ingots were hot-rolled at 900 degrees C, it cooled promptly. In order to remove a surface oxide film, after carrying out facing to 9mm in thickness, 0.25mm in thickness was processed with cold rolling. Then, the making a test specimen solution-ize with recrystallization purpose, heat treatment for 30s was performed at 750 degrees C, and it quenched with the cooling rate of 15 degrees C/s or more immediately. The aging treatment performed heat treatment of 515 degree-Cx 2 hours in the inert atmosphere, and was taken as the material with which an examination is presented.
[0034] It sampled from the manufactured material, the grain size number was measured, and various characterization of fracture surface (%) and a ratio, and a barricade (micrometer) was performed as TS(tensile strength)N/mm2, El(elongation) %, EC (conductivity) %IACS, bending nature, S.R.R(rate of stress relaxation) %, Sn plating detachability, and punching nature.
[0035] The grain size number, i.e., the size of crystal grain, observed by using a comparison method and an intercept method together according to JISH0501. In the comparison method, microscope observation (75 times or 200 times) was carried out, and the test piece was measured. At the intercept method, it measured in the board thickness cross section parallel to the processing direction. Tensile strength is JISZ2241 and measured conductivity as a value which shows the conductivity of heat and the electrical and electric equipment according to JISH0505.
[0036] As for evaluation of bending nature, the inside bend radius performed 180-degree adhesion bending of OR. the index of evaluation -- A. wrinkling -- there is nothing -- fitness B. -- C. by which a small wrinkling is observed -- D. which has not resulted in the crack although a big wrinkling is observed -- E. by which a detailed crack is observed -- it evaluated in observing [a crack]-clearly 5 stage, and more than the evaluation C was judged to be the level which is satisfactory practically

[0037] Evaluation of a stress relaxation characteristic was performed based on EMAS-3003 which are the JEOL material Semiconductor Equipment & Materials International standard. The ****** block formula was adopted here, load stress was set

up so that 450Ns /of surface maximum stress might be set to 2 mm, and it examined by the 150-degree C thermostat. The rate of relief after 1000hr examinations (S. R.R) showed to Table 4 - 6.

[0038] The ****** block sequence of the test method of stress relaxation is shown in drawing 1 (a), (b), and (c). It is a perspective diagram and (b) is a side elevation, and drawing 1 (a) supports one side of a sample (1) by the attachment component (3) to a pedestal (2) at support-at-one-end ******, and changes another side into the state where it was distorted to the sample (1) with a block (4), and deltao (initial deflection variation rate) was given. Predetermined-time (this example 1000 hr(s)) heating of the sample (1) is carried out in this state at 150 degrees C. As shown in the side elevation of drawing 1 (c) after predetermined-time progress, distortion deltat (permanent deflection variation rate) in the state where the block (4) was removed was measured, and it asked for the rate of stress relaxation (%) by the following formula.

rate (%) of stress relaxation =(deltat/deltao) x100 -- in addition -- initial deflection -- a variation rate is calculated from Young's modulus, board thickness, etc. so that surface maximum stress may become a predetermined value (450N/mm2) (the calculation method is based on EMAS-3003)

[0039] The heating detachability of Sn plating evaluated plating ablation of the portion by viewing, after carrying out air heating of 150 degree-Cx 1000 hours for the test piece which gave 1-micrometer gloss Sn plating, and it carried out 180 adhesion bending and bend return. When ablation of solder was accepted, it was described in Tables 4-6 as "**."

[0040] Punching nature was investigated by examining by piercing with metal mold (product made from SKD11) (a 1mmx5mm square hole being prepared). And the punching side of the sample extracted from a part for the 5001st time to the 10000th punching at random 20 pieces was observed, and the thickness of the fracture section was measured. The average of the rate of the thickness of the fracture section to the thickness of a test piece is shown in Tables 4-6 by % display (it is displayed as F.A.R in front Naka). The height of the barricade of the sample similarly extracted from the 5001st time to the 10000th punching portion at random 20 pieces was found with the contact process configuration measurement machine also about barricade measurement, and the average was indicated to the table.

[Table 1]

[Table 2]

	No	Ni	Si	Mg	Sn	Zn	S	O	その他	結晶粒度
比較例	22	0.8	0.18	0.08	0.34	0.50	0.002	0.001		5
	23	3.8	0.95	0.08	0.33	0.49	0.002	0.001		↑
	24	2.0	0.47	0.003	0.33	0.49	0.002	0.001		↑
	25	2.0	0.48	0.002	0.99	0.50	0.002	0.001		↑
	26	1.9	0.47	0.25	0.33	1.25	0.002	0.001		↑
	27	2.0	0.48	0.08	0.002	0.50	0.002	0.001		↑
	28	2.0	0.48	0.08	2.04	0.50	0.002	0.001		↑
	29	2.1	0.47	0.08	0.31	5.09	0.002	0.001		↑
	30	2.0	0.47	0.07	0.33	0.49	0.002	0.001	Fe0.35	↑
	31	1.9	0.48	0.08	0.32	0.48	0.002	0.001	Pb0.25	↑
	32	1.9	0.46	0.09	0.33	0.49	0.011	0.001		↑
	33	2.0	0.48	0.08	0.32	0.50	0.002	0.007		↑
	34	2.0	0.47	0.08	0.31	0.50	0.002	0.001		≦1
	35	2.0	0.48	0.08	0.32	0.49	0.002	0.001		30

[Table 3]

	No	Ni	Si	Mg	Sn	Zn	S	O	その他	結晶粒度
比較例	36	2.0	0.47	0.07	0.002	0.49	0.002	0.001	Cr0.10	5
	37	1.9	0.48	0.08	0.001	0.48	0.002	0.001	Mn0.39	↑
	38	2.0	0.48	0.08	0.002	0.50	0.002	0.001	B0.008	↑
	39	2.0	0.47	0.08	0.001	0.50	0.002	0.001	Al0.50	↑
	40	2.0	0.48	0.08	0.001	0.50	0.002	0.001	Ti0.10	↑
	41	2.0	0.48	0.08	0.002	0.49	0.002	0.001	In0.10	↑
従来例	42	2.5	0.60	–	–	–	–	–		
	43	1.9	0.50	–	0.4	0.9	–	–		
	44	2.7	0.65	0.17	–	–	–	–		

[Table 4]

	No	TS N/mm²	El %	EC %IACS	曲げ加工性	S.R.R %	Snﾒｯｷ剥離性	打ち抜き性	
								F.A.R(%)	ﾊﾞﾘ(μm)
本発明例	1	610	16	39	B	22	剥離無し	42	9
	2	670	16	39	B	18	↑	45	6
	3	680	15	38	B	17	↑	46	6
	4	680	14	38	C	17	↑	50	5
	5	660	16	40	B	22	↑	44	7
	6	680	16	33	B	18	↑	46	7
	7	680	15	32	B	14	↑	47	8
	8	670	16	38	C	14	↑	47	6
	9	670	16	36	B	14	↑	51	4
	10	670	16	37	B	18	↑	50	4
	11	680	15	33	C	18	↑	41	10
	12	680	15	31	B	14	↑	54	3
	13	710	15	42	B	15	↑	49	4
	14	700	16	40	B	16	↑	47	4
	15	680	16	39	B	18	↑	45	7
	16	670	16	39	B	19	↑	55	2
	17	660	15	41	B	19	↑	45	8
	18	680	14	39	C	20	↑	46	6
	19	670	16	39	B	18	↑	44	7
	20	670	16	39	B	18	↑	41	9
	21	660	13	39	C	19	↑	39	11

[Table 5]

	No	TS N/mm²	El %	EC %IACS	曲げ加工性	S.R.R %	Snﾒｯｷ剥離性	打ち抜き性	
								F.A.R(%)	ﾊﾞﾘ(μm)
比較例	22	480	19	51	A	—(*)	剥離無し	31	19
	23	680	14	38	D	17	↑	49	4
	24	670	16	40	B	33	↑	40	11
	25	680	16	32	B	31	↑	42	11
	26	670	15	34	D	13	↑	58	2
	27	670	16	42	B	24	↑	45	5
	28	690	15	23	B	13	↑	46	6
	29	680	17	29	B	18	↑	56	2
	30	530	18	43	D	—(*)	↑	37	17
	31	熱間加工中に割れが生じたため製造中止							
	32	熱間加工中に割れが生じたため製造中止							
	33	670	10	40	D	23	剥離無し	46	6
	34	680	12	39	D	22	↑	45	8
	35	650	9	39	D	25	↑	40	12

[Table 6]

	No	TS N/mm²	El %	EC %IACS	曲げ加工性	S.R.R %	Snメッキ剥離性	打ち抜き性 F.A.R (%)	打ち抜き性 バリ (μm)
比較例	36	650	17	42	B	24	剥離無し	44	8
	37	670	15	35	B	25	↑	46	7
	38	670	16	40	B	25	↑	41	11
	39	670	16	35	B	23	↑	47	8
	40	660	15	40	B	26	↑	46	9
	41	680	16	39	B	24	↑	44	10
従来例	42	670	17	46	B	34	剥離有り	38	13
	43	650	16	38	B	33	剥離無し	37	13
	44	680	11	44	D	19	剥離有り	40	11

[0041] It turns out that the examples 1-21 of this invention show the property which was excellent in all of the various properties of TS (tensile strength), El (elongation), EC (conductivity), bending nature, S.R.R (rate of stress relaxation), Sn plating detachability, and punching nature so that clearly from Table 4.
[0042] On the other hand, the target intensity is not obtained but punching processability is also inferior in example No.of comparison 22 with few amounts of nickel-Si as compared with other materials. Conversely, although there was no difference in respect of intensity as compared with example No.of this invention 4 with little example No.of comparison 23 in the amount of nickel-Si with many amounts of nickel-Si, bending nature showed the degradation inclination. That is, since bending nature is inferior, it is unsuitable as a terminal and an object for connectors to add nickel-Si more than the amount specified by this invention.
[0043] Example No.of comparison 24 with few additions of Mg are sharply inferior in the stress relaxation characteristic as compared with No.2 of the example of this invention, and No.5. Example No.of comparison 25 are inferior to example No.of this invention 6, and No.7 by the same reason as this. even if this adds Sn independently into the conventional Cu-nickel-Si alloy (conventional example No.42), it shows that the big improvement effect is not expectable in a stress relaxation characteristic, and is in agreement in the property of the conventional Cu-nickel-Si alloy containing Sn (conventional example No.43)
[0044] As for example No.of comparison 26 whose addition of Mg is more than the amount of conventions of this invention, bending nature has deteriorated. This is unsuitable as a terminal and connector material. Zn which can improve bending nature a little -- more than 1wt% -- even if it added, good bending nature was not securable Example No.of comparison 27 with few additions of Sn are inferior in respect of the stress relaxation characteristic as compared with No.2 of the example of this invention. Conversely, example No.of comparison 28 with many additions of Sn were one of the composition which showed the stress relaxation characteristic which was most excellent in in having performed the effect of Mg, a phase ball, and this time manufacture. However, conductivity becomes the lowest and it cannot be said that it excels in balance. Conductivity becomes low and example No.of comparison 29 with many additions of Zn are not excellent in property balance.
[0045] The Fe-Si compound generated so much example No.of comparison 30 whose addition of Fe is more than the amount of conventions, and the amount of precipitation hardening not only fell, but they had the bad influence on bending nature. Example No.of comparison 31 which made [many] the addition of Pb produced the crack during hot working, and were not able to manufacture it normally. In addition, the crack arose at the time of hot working, and example No.of comparison 32 which have S out of this invention range were not able to perform subsequent characterization. Moreover, the oxide of Mg was generating [O] many example No.of comparison 33, and bending nature deteriorated.
[0046] Example No.of comparison 34 performed annealing for making it recrystallize in 680 degree-Cx30s. Consequently, average crystal grain is 1 micrometer or less, and became the organization where comparatively big crystal grain and small crystal grain are intermingled. Depending on the place which extracts the test piece which performs bending nature, a result which produces a crack was brought for the uneven organization. On the contrary, since example No.of comparison 35 heat-treated in 930 degree-Cx30s, crystal grain was set to about 30 micrometers. Since it became big and rough crystal grain, it not only has a bad influence on bending nature, but the stress relaxation characteristic declined a little.
[0047] Moreover, example No.of comparison36-No.41 are the example of comparison which added elements other than Sn into the Cu-nickel-Si-Mg-Zn alloy. Any [these] stress relaxation characteristic of an alloy is a stress relaxation characteristic of the same grade as example No.of comparison 27 with few additions of Sn, and it turns out that addition of these elements hardly contributes to stress relaxation.
[0048] Next, if it sees about the alloy which exists from the former, conventional example No.42 are an Cu-nickel-Si alloy, and other alloying elements are not contained. In this case, since a stress relaxation characteristic does not contain the point which is not good, and Zn, a problem is in the heating detachability of Sn plating. Conventional example No.43 are as point ** the material which added Sn and Zn into the Cu-nickel-Si system alloy. Although the heating detachability of Sn plating improves, the stress relaxation characteristic is equivalent to conventional example No.41, and inadequate.
[0049] No.44 are the material which added Mg and aimed at the improvement of a stress relaxation characteristic. Although the stress relaxation characteristic improves according to the effect of Mg, a problem is in bending nature. In order to obtain a stress relaxation characteristic equivalent to these conventional example No.44, and good bending nature, it is attained by reducing the amount of Mg, adding Sn like example No.of this invention 2, and adding Zn which improves bending nature further. The heating detachability of Sn plating is also improved according to the Zn addition effect.
[0050]
[Example 2] Table 7 and Table 8 explain the 2nd example of this invention. As the alloy which consists of composition of example No.of this invention 2 shown in the above-mentioned example 1 is manufactured at the process depended table 7 and is shown in Table 8, the 2nd example Various characterization of F.A.R, and a (%) and a barricade (micrometer) was performed as TS(tensile strength)N/mm2, El(elongation) %, EC(conductivity) %IACS, bending nature, S.R.R(rate of stress relaxation) %, Sn

plating detachability, and punching nature. The evaluation method is the same as that of an example 1.
[Table 7]

	No	再結晶処理 ℃×s	冷間加工 加工率%	時効条件 ℃×hr	最終加工 加工率%	最終焼鈍 ℃×hr	
本発明例	45	750×30	処理無し	515×2	0	処理無し	No. 2と同じ
	46	725×30	↑	↑	↑	↑	No. 18と同じ
	47	800×30	↑	↑	↑	↑	No. 19と同じ
	48	850×30	↑	↑	↑	↑	No. 20と同じ
	49	900×30	↑	↑	↑	↑	No. 21と同じ
	50	750×30	↑	535×2	↑	↑	
	51	↑	20	500×2	↑	↑	
	52	↑	処理無し	515×2	10	375×2	
	53	↑	↑	↑	20	350×2	
比較例	54	680×30	処理無し	515×2	0	処理無し	No. 34と同じ
	55	930×30	↑	↑	↑	↑	No. 35と同じ
	56	750×30	↑	400×2	↑	↑	
	57	750×30	↑	560×2	↑	↑	
	58	750×30	↑	515×2	33	350×2	
	59	750×30	↑	515×2	20	処理無し	

[Table 8]

	No	TS N/mm²	El %	EC %IACS	曲げ加工性	S. R/R %	Snメッキ剥離性	打ち抜き性 F. A. R(%)	打ち抜き性 バリ(μm)
本発明例	45	670	16	39	B	18	剥離無し	45	6
	46	680	14	39	C	20	↑	46	6
	47	670	16	39	B	18	↑	44	7
	48	670	16	39	B	18	↑	41	9
	49	660	13	39	C	19	↑	39	11
	50	640	17	40	B	21	↑	46	7
	51	680	12	40	B	17	↑	49	5
	52	670	13	39	B	17	↑	47	7
	53	680	12	40	B	16	↑	50	5
比較例	54	680	12	39	D	22	剥離無し	45	8
	55	650	9	39	D	25	↑	40	12
	56	550	19	35	B	29	↑	31	14
	57	540	18	42	A	30	↑	34	11
	58	730	8	40	D	16	↑	53	3
	59	730	4	38	D	22	↑	61	2

[0051] Each example No.of this invention45-No.53 which is the alloy manufactured at the process of the example of this invention showed the outstanding property so that clearly from Table 7 and Table 8. However, example No.of comparison 54 had low heat treatment temperature, crystal grain was not uniform as a result, and bending nature deteriorated. Since example No.of comparison 55 heat-treated in 930 degree-Cx30s, crystal grain was set to about 30 micrometers. Since it was big and rough crystal grain, it not only has a bad influence on bending nature, but the stress relaxation characteristic declined a little.
[0052] Example No.of comparison 56 had low aging temperature, and the inadequate hatchet strength property deteriorated [the deposit]. The stress relaxation characteristic also declined sharply simultaneously. Conversely, No.57 had high aging temperature, and since the sludge turned big and rough, the stress relaxation characteristic declined sharply. Example No.of comparison 58 are the example which performed cold working by the above working ratio specified by this invention after aging. Although the stress relaxation characteristic was excellent rather, bending nature fell. Although the rate of cold working after aging of example No.of comparison 59 is not high, it is the example which did not perform the postheat treatment. Elongation is low and not only bending nature fell, but the stress relaxation characteristic declined a little.
[0053]

[Effect of the Invention] As described above, the copper alloy of this invention deposits the compound of nickel and Si in Cu matrix, and does so the effect that the copper alloy which combines the outstanding mechanical property, conductivity, a stress relaxation characteristic, and bending nature is obtained, Sn, Mg, or by having carried out the amount addition of specification of the Zn further, having restricted S and O content, and having exceeded 1 micrometer and having set the grain size number to 25 micrometers or less. Since it excels in intensity, conductivity and a stress relaxation characteristic, and a bending moldability and excels also in the heating-proof detachability of Sn plating, or punching nature as a terminal and an object for connectors especially, it can respond to small and highly-efficient-izing which are an inclination in recent years suitably. Moreover, although this invention is suitable for a terminal and a connector use, the effect of offering a copper alloy suitable also as general electrical conducting materials, such as a switch and relay material, is done so.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing explaining the examination of the stress relaxation of this invention example
[Description of Notations]
1 Sample
2 Pedestal
3 Attachment Component
4 Block

[Translation done.]

* NOTICES *

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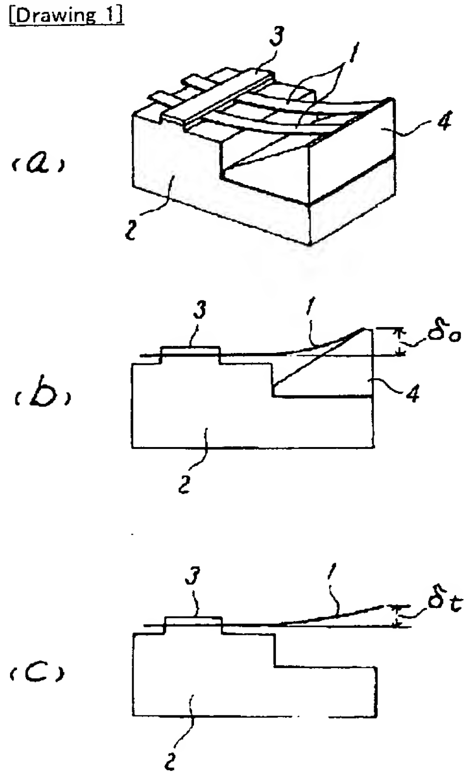
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Translation done.]